

INFORMATION ABOUT THE THESIS

Full name of PhD student: **Tran Si Kien**

Thesis title: “*Dynamic and optimal motion control of industrial manipulators based on Pontryagin’s maximum principle*”.

Speciality: Mechanical Engineering

Code: 9520103

Full name of scientific instructors:

1. Dr. Phan Dang Phong
2. Prof. D.Sc. Do Sanh

Training institution: National Research Institute of Mechanical Engineering

SUMMARY OF NEW CONCLUSION OF THE THESIS

1. Scientific significance

- This study develops the theoretical foundations and a methodological framework for the optimal control problem of industrial robotic manipulators.

- It determines optimal control-effort trajectories for several planar manipulators, thereby clarifying the applicability of an approach based on Pontryagin’s principle to the optimization of industrial robotic manipulator motion.

- The thesis contributes certain findings to the research direction of optimal control for open-chain robotic manipulators.

- The proposed theoretical research method, combined with simulation, can serve as a reference basis for further scientific studies on robotic manipulator control.

2. Practical significance

- The proposed research method can support the selection of motion strategies aimed at reducing control effort and improving the operational efficiency of robotic manipulators in industrial processes.

- The findings of the thesis can provide a useful reference for input parameters, dynamic models, cost functions, and simulation data for further studies on intelligent control and data-driven optimization of robot motion.

3. New contributions of the thesis

- The dissertation proposes a methodological framework for the dynamic analysis and optimal motion control of industrial robotic manipulators. Building upon established methods, including the transfer matrix method, the matrix form of

Lagrange's equations, the compatibility principle, and Pontryagin's maximum principle, the dissertation organizes and integrates these methods into a unified procedure for formulating kinematic and dynamic models, handling trajectory constraints, and deriving optimal control conditions. The novelty lies in the integration of these theoretical tools within a single methodological framework that directly addresses representative motion problems of industrial robotic manipulators.

- The dissertation formulates optimal control problems for several typical motion modes of industrial robotic manipulators, considering prescribed terminal conditions and trajectory constraints. Different types of motion are expressed within a common optimal control framework, with direct consideration of the manipulator's dynamic structure, load variations between the outbound and return phases, and the influence of the execution time of each phase, rather than treating them merely as separate geometric trajectory-planning problems.

- The optimal control laws are validated through numerical simulations for several representative planar manipulator models. Quantitative comparisons are conducted in terms of the optimization criterion against selected motion laws and alternative methods, thereby demonstrating the applicability of the proposed approach.

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Opinion of the science instructors

PhD student

Dr. Phan Dang Phong

Prof. D.Sc. Do Sanh

Tran Si Kien